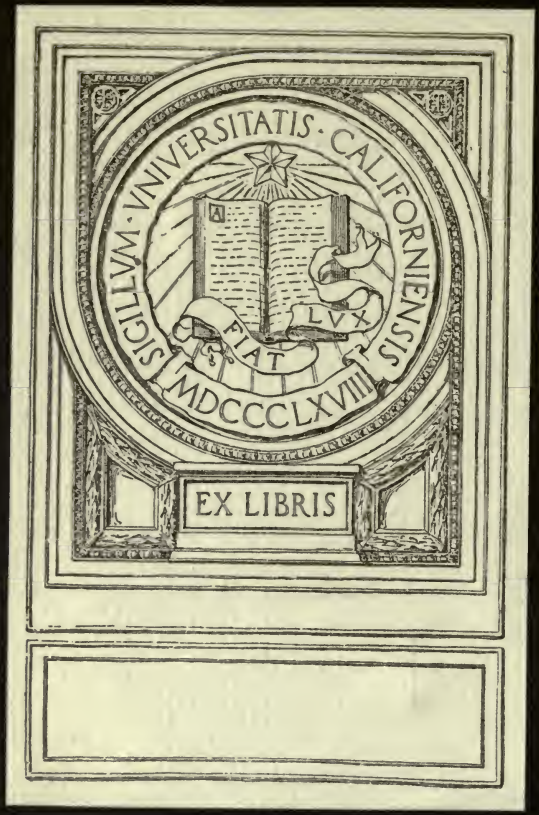
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Mechanical Maneuvers

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Mechanical Maneuvers

Mechanical maneuvers are the application of machines and of mechanical power for mounting, dismounting, moving, and transporting artillery.

It is of the utmost importance that officers and enlisted men designated to execute work of this nature have a knowledge of:

1. The machines, appliances and tools required.
2. How to improvise material.
3. The breaking strength and safe load of the material used.
4. How to obtain the greatest advantage from the power applied.
5. The safest and speediest method to be used.

The machines and appliances usually employed for moving heavy artillery are:

Rope, blocks and tackle
Handspikes (Levers)
Hydraulic Jacks
Gins
Shears
Derricks
Blocks, skids, wayplanks and Rollers
Collars
Chocks
Cradles
Capstans, crab or drum
Sling carts
Tractors
R. R. Trucks
Push carts
Mauls
Sledge Hammer
Hatchet
Axe
Hand saw
Crosscut saw
Nails

There is a wrong way and a right way to do everything. There is no condition when the wrong way is more fraught with the possibilities of disaster than in the handling of heavy weights or vehicles with improvised tackle. There may be a time when the tackle that jams or the knot that refuses to be freed, may be as dangerous to life or equipment as the tackle that breaks or the hitch that slips. It is very easy to master the simple nomenclature of the rigger, and it is equally simple to learn the few knots, splices, hitches, and riggings necessary to meet any situation that may arise in the Coast Defenses or in the field.

Cordage

A *Yarn* is a thread formed by twisting several fibres together, hemp or other fibrous material. The common fibres are: *Manila, Hemp, Jute,* and *Sisal.* Manila fibre is best for ordinary use and rope made of it should always be used if possible. *Hemp* is stronger but not so flexible and deteriorates more rapidly from moisture.

A *Strand* is a number of these yarns twisted or spun together; three or four strands form a rope if, after they are twisted together, they measure at least one inch or more in circumference.

Wire Rope contains a number of wires twisted into strands, three or six of which are laid up around a wire or hemp core. Wire rope is abiut six times as strong as hemp rope but lacks elasticity and is difficult to handle. Inasmuch as it is used principally for permanent rigging and not adapted for field work, it will not be further considered here.

Ropes are ordinarily composed of three strands laid up right handed, so that when a strand is followed away from the observer the rotation will be clock-wise, or laid up with the sun. This is known as *Hawser-Laid, Plain Laid,* or *Right Handed Rope. Hawser* is also a term applied to larger rope.

Shroud Laid Rope contains four strands usually laid right handed around a smaller rope called a *Heart* or *Core.*

Spun Yarn is made by twisting together, very loosely, two or more well tarred *Yarns,* and is also designated by numbers of yarns, as two yarn, three yarn, etc. It is used for *Serving, Seizing. Stops, Mousing,* etc.

Marline is also made of tarred yarn, but it is tightly twisted and much harder and smoother than spun-yarn. It is not fit for serving, when the rope served is to be bent up, as it is not pliable enough to cover the rope in such cases.

The *Jaws* of a rope are the spaces between the strands. A rope is *Long Jawed or Short Jawed* as it is loosely or tightly laid up.

The *Lay* of a rope is the direction of twist of the strand of the rope, it is opposite to the twist of yarns in the strands. This causes the rope to lay together when put under a strain, and the *Yarns* and *Strands* to bind together against each other in all directions.

The *Standing Part* is the principal portion or longest part of the rope.

The *End* is the free end used in forming a knot or hitch.

The *Bight* of a rope is any part not an end. For example a *Bight* is a loop formed by binding or doubling the rope.

To *Whip* a rope is to bind its end with a bit of yarn or twine to prevent its unraveling.

A rope is *Seized* when two parts of it are bound together by spun yarn, marline or cord. *Round Seizing* is when the seizing material is wound round both ropes without passing between them, while in *Racking Seizing* the seizing material is wound round the rope in figures of eight.

Pointing is the operation of tapering the end of a rope so that it will enter a hole or block more easily.

Frapping is several turns about two or more ropes to bind them as about lashing, or to draw two ropes and hold them while taking in slack.

Lashing is the binding or making fast of one object to another by means of ropes.

A *Strap* or *Sling* is usually made of rope, the ends of which are either spliced or tied together; it is passed round the object to be moved, the hook of the tackle being passed through both bights, or through one bight after it has been passed through the other one.

Mousing a hook is to place seizing about the point and back of the hook to strengthen it, and to prevent it from disengaging itself.

Worming a rope is filling up the jaws by passing spun yarn along them, to render the surface smooth for parceling and serving.

Parceling a rope is wrapping narrow strips of canvas about it, well tarred in order to secure it from being injured by water. The parceling, is put on with the lay of the rope. Its use is to prevent chafing or cutting of a rope when a strain is brought against a rough surface or sharp edge. For this purpose old rope or canvas wound around is sufficient.

Serving is the laying on of spun yarn or other small material in turns round the rope, close together, and hove taut by use of a serving board for small rope and serving mallet for large rope. Small ropes are sometimes served without being wormed, as the crevices between the strands are not large enough to make the surface very uneven; but a large rope is always wormed and parceled, before being served. The service is put on against the lay of the rope.

Cable-Laid rope is composed of nine (9) strands, and is made by first laying up three ropes of three strands each, with the sun, and then laying the three ropes up together into one, against the sun.

Right-Hand rope must be coiled with the sun, and *Cable-Laid* rope against the sun.

The fibers of Hemp rope are obtained from the Hemp Plant, those of Manila Rope from a species of Plantain. Hemp Rope is about one-third stronger than Manila.

The size of rope is always given in inches and fractions, and is measured, on the circumference, for the reason that it is seldom possible to get a squarely cut end in order to measure the diameter. In making requisitions for rope, it should be clearly indicated that this measure is the one considered.

Preservation in Store. Ropes should be placed in the upper stories of buildings, coiled up and labeled; large ropes on skids, allowing free circulation of air; small ropes hung up to the joists on pins or hooks. Ropes should not be coiled until perfectly dry; they should be uncoiled every year, and stretched out for several days in the dry season. Ropes long in store lose their strength.

A safe general rule for calculating roughly the strength of all ropes is as follows: one fourth the square of the circumference gives the breaking weight in tons of 2000 pounds. Due allowance must be made for loss of strength by wear and tear.

When using tackles, multiply the weight thus found by one-half the number of sheaves in the blocks.

Old rope should be carefully examined before attempting to work with it. A few months exposure weakens a rope 20 to 50 per cent. Dry rot will sometimes make a rope almost useless without changing its external appearance to any extent. Rope will sometimes chafe to powder in the center, due to friction between the strands and yarns while being bent over the sheaves of blocks. A rope is slightly weakened by tarring and wetting. Dry ropes shorten quite perceptibly upon being wet and for this reason it is never safe to leave a tension on rigging when it is liable to be wet, if an increase on that tension will cause damage.

Rope should always be stopped up, either with the ends or with the rope-yarn stops, to prevent it getting into a snarl. When using ropes for hauling, they should never be dragged upon the ground.

To stop up a coil of rope with the end. Lay off two or three turns of the coil and take a clove hitch around all parts of one side of the coil. Do the same on the other side. If the rope should be rove in a tackle, run it "two blocks" and make a hitch around the fall between the blocks.

Knots and Splices

The principle of the knot is that no two parts which would move in the same direction, if the knot were to slip, should lie along side or touching one another.

The *Square Knot* and *Thief Knot* are excellent illustrations of this principle.

Square Knot. Take an over-hand knot around a spar; take an end in each hand and cross them on the same side of the standing part on which they come up, pass one end around the other, and bring it up through the bight. This is sometimes called a *Reef Knot.* If the ends are crossed the wrong way, sailors call it a *Granny Knot.* If the ends come out on opposite sides it is a *Thief Knot.*

Single Becket or *Sheet Bend (Weaver's Knot).* Pass the end of a rope up thru the bight of another, round both parts of the other, and under its own part. This does not jam and is useful in tying two ropes together.

Double Becket. Same as single becket except two turns are taken round both parts before passing under its own part. Used to tie ropes of different sizes together. The bight should be taken in the larger ropes.

Two Half Hitches. Pass the end of the rope around the standing part and bring it up thru the Bight. This is a half hitch. Take it around again in the same manner for two half hitches.

Round Turn and Two Half Hitches. Take a round turn around a stake or post, and secure the end by two half hitches around the standing part. This is very useful in securing guys to the stakes.

Fisherman's Bend (Anchor Knot). Take two turns around the spar with the end of the rope; hitch the end around the standing part and thru both turns, and then pass the end over the second and under the first turn. This knot will not jam when wet.

A Timber Hitch. Take the end of a rope around the spar, lead it under and over the standing part, and pass two or more turns around its own part; pass the first turn over the end part instead of thru the bight, as in the half hitch. Used in temporarily securing the ends of ropes to spars.

A *Clove Hitch* is made by passing the end of a rope round a spar, over, and bringing it under and round behind its standing part, over the spar again and up thru its own part. It may then,

if necessary, be stopped or hitched to its own part, the only difference between two half hitches and a clove hitch being that one is hitched round its own standing part and the other is hitched round a spar or another rope.

A *Rolling Hitch.* Pass the end of a rope round a spar; take it round the second time, nearer to the standing part; then carry it across the standing part, over and round the spar and up thru the bight. A strap or tail block is fastened to a rope by this hitch. Used in shifting the fall from one end of the windlass to the other. (See Nipper and screw).

A *Blackwall Hitch.* Form a bight by putting the end of a rope across and under the standing part; put the hook of a tackle thru it, the center of the bight resting against the back of the hook, and the end jammed in the bight of the hook by the standing part of the rope.

A *Cat's Paw.* Make a large bight in a rope, and spread it open, putting one hand at one part of the bight and the other at the other, and letting the standing part and end come together, turn the bight over from you three times, and a small bight will be formed in each hand, bring the two small bights together, and put the hook of the tackle thru them both. This is very useful in applying a purchase or tackle to the fall of another.

A *Sheep Shank.* Make two long bights in a rope which shall overlay one another, take a half hitch over the end of each bight with the standing part which is next to it. Used to shorten rope, or cut out a weak part, temporarily.

A *Bowline Knot.* Take the end of a rope in your right hand and the standing part in your left; lay the end over the standing part, and with the left hand make a bight of the standing part over it; take the end under the lower standing part up over the cross, and down thru the bight. This is very useful in forming a temporary eye at the end of a rope.

Bowline on a Bight. The first part is made like the above bowline, with the double part of a rope, then the bight is pulled thru sufficiently to allow it to be bent past and come up in the position shown. It makes a comfortable sling for a man, more so than a single bight, as the bights may be adjusted to an equal length.

Running Bowline. This is simply a bowline with a bight enclosing the standing part.

A *Marlinespike Hitch.* Lay the marlinespike upon the seizing stuff, and bring the end over the standing part so as to form a bight, lay this bight back over the standing part, putting the

marlinspike down thru the bight, under the standing part, and up thru the bight again. Very useful in putting on lashings, etc.

Carrick Bend. Form a bight on a rope and lay the end across the standing part; stick the bight of another rope up thru the loop thus formed, and carry the end of the first rope, under the standing part, and thru the loop formed by its bight, stop each end to its own standing part.

Splicing is putting the end of ropes together by opening the strands and placing them into one another, or by putting the strands of the end of a rope between those of the bight.

A *Short Splice.* Unlay the strands for a convenient length, then take an end in each hand, place them one within the other and draw them close. Hold the end of one rope and three strands which came from the opposite rope fast in the left hand, or if the rope be large, stop them down to it with a rope-yarn. Take the middle strand, which is free, pass it over the strand which is first next to it, then thru under the second and out between the second and third from it, then haul it taut. Pass each of the six strands in the same manner; first, those of one end and then those of the other. The same operation may be repeated with each strand, passing each over the third strand from it, and under the fourth, and thru, or, as is more usual, after the ends have been stuck once, untwist each strand, divide the yarns, pass one-half as above described, and cut off the other half. This tapers the splice.

A *Long Splice.* Unlay the ends of two ropes to a distance three or four times greater than for a short splice, and place them within one another as for a short splice. Unlay one strand for a considerable distance and fill up the interval which it leaves with the opposite strand from the other rope. Twist the ends of these two together, then do the same with two more strands. The two remaining strands are twisted together in the place where they were first crossed. Open the two last named strands, divide in two, take an overhand knot with the opposite halves, and lead the ends over the next strand and thru the second as the whole strands were passed for the short splice. Cut off the other two halves. Do the same with the others that are placed together, dividing, knotting, and passing them in the same manner. Before cutting off any of the half strands, the rope should be brought well upon a stretch. Sometimes the whole strands are knotted, when divided, and the half strands passed as above described. This splice does not increase the diameter of the rope and is used for splicing a fall or other rope that runs thru blocks or pulleys.

USE OF KNOTS

Overhand Knot is used at the end of a rope to prevent unreaving or to prevent the end of a rope from slipping thru a block.

Figure of Eight is used for purposes similar to the above.

Square or *Reef Knot* is used for joining two ropes of the same size. With dry rope a reef knot is as strong as the rope; with wet rope it slips before the rope breaks, while a double sheet bend or (Double Becket) is bound to hold.

Single Sheet Bend (Single Becket) is used for joining ropes together, especially when unequal in size. It is more secure than the Reef Knot but more difficult to untie. This is also known as a Weaver's Knot.

Double Sheet Bend or (Double Becket) is used also for fastening ropes together of unequal size, especially wet ones, and is more secure than the single sheet bend.

Two Half-Hitches is especially useful for belaying or making fast the end of a rope around its own standing part. The end may be lashed down, or seized, to the standing part with a bit of spun yarn. This adds to its security and prevents slipping. This knot should *never* be used for hoisting a spar.

Round Turn and Two Half-Hitches is like the preceding, except that a turn is first taken around the spar or post.

Anchor Knot is used for fastening a rope to a ring or an anchor.

Clove Hitch, generally used for fastening a rope at right angles to a spar, or at the commencement of a lashing. If the end of the spar is free the hitch is made by first forming two loops, and placing the right-handed loop over the other one, then slipping the loop over the end of the spar.

Timber Hitch, is used for hauling and lifting spars. It can be easily loosed when the strain is taken off, but will not slip under pull. When used for hauling spars, a half-hitch is added near the end of the spar.

Telegraph Hitch, is used for hoisting or hauling a spar.

Hawser Bend, is used for joining two large cables. Each end is seized to its own standing part.

Cat's Paw. It gives a double bearing surface, and will not cut the rope.

Sheep Shank is used for shortening a rope, or to pass by a weak spot, a half hitch is taken with the standing parts around the Bights.

Mooring Knot. Take two turns round the moorings or snubbing post; pass the free end of the rope under the standing part;

take a third turn above the other end and pass the free end between two upper turns.

Rolling Hitch, used for hauling a large rope or cable. Two turns are taken around the large rope in the direction in which it is to be hauled, and the one-half hitch made on the other side of the hauling part. A most useful knot, and quickly made. For armored cable or wet manila rope, the hitch must be made with a strap of rope yarn. Rope will not hold.

Blackwall Hitch, is used for attaching a single rope to a hook of a block for hoisting. A variation is the *Midshipman's Hitch;* the end is brought round the point of the hook, over the standing part.

DIMENSIONS, WEIGHT, AND STRENGTH OF MANILA ROPE
(Taken from Eng. Field Manual)

Diameter	Circumference	Weight in pounds per 100 feet.	Breaking Load.	Proper working Load depending upon age and condition.
Inches	Inches		Pounds	Pounds
0.32	1	3.3	780	120–390
.48	1½	7.4	1600	250–800
.64	2	13.2	2730	350–1300
.80	2½	20.6	4300	600–2000
.96	3	29.7	6100	900–2800
1.11	3½	40.4	8500	1100–4000
1.27	4	52.8	11600	1500–5000
1.43	4½	66.8	15000	2000–6500
1.59	5	82.5	18400	2600–8000
1.75	5½	99.8	22000	3000–10000
1.91	6	119	25000	3500–11500
2.07	6½	139	29100	4000–13000
2.23	7	162	32700	4600–15000
2.39	7½	186	36300	5000–16000

Up to 5 inches in circumference rope is made in coils of 1200 feet.

Blocks and Tackles

The parts of a *Block* are the *Shell,* or *Frame,* the *Sheaves* or wheel upon which the rope runs, and the *Pin* upon which the Sheaves turn in the shell; and the sides of the shell are the *Cheeks* and the *Swallaw* is the spare between the sheave and the frame through which the rope passes. A *Strap* of iron or yoke is passed around the *Shell* and forms attachments for a *Hook* atone end, and an *Eye* at the other.

Blocks are made of *Wood, Wood* and *Metal,* and entirely of *Metal.* In the latter case, the *Strap* is replaced by bolts at top

and bottom, or the strap runs through the *Eye* of the *Hook* and has a bolt securing the two ends at the bottom through a metal grommet.

Blocks are designated by the *Length of the Shell in Inches* and by the *Number of Sheaves.* The largest rope a wooden block will take has a circumference equal to one-third the length of the shell. Self-lubricating blocks may be obtained and are to be preferred. Blocks with one, two, three or four sheaves are called *Single, Double, Triple* or *Quadruple* blocks.

A *Snatch Block* is a single block with a shell and strap open at one side to admit a rope without passing the end through.

A *Tail Block* is a Single block, strapped with an *Eye Splice,* and having a long end left by which to make the block fast to any object.

Wooden blocks should be kept properly protected from weather and damage from rough handling, well filled with paint and properly lubricated.

Metal blocks should be painted, oiled and kept free from rust. All blocks should be watched for cracked shells or sheaves and worn pins.

TACKLES

A Tackle is a combination of ropes and blocks working together to aid in moving heavy weights. The moving block is the running block, the fixed block is the standing block. From where the end of the rope is made fast to one block to where it passes over the first sheave in the other block, is called the *Standing Part,* the rope between the blocks is the *Running Part,* and the part to which the *Pull* is applied is called the *Fall.*

A *Simple Tackle* consists of one or more Blocks rove with a single rope or fall. The end of the fall fixed in the Tackle is called the *Standing End;* the other is the *Running End.*

To *Over Haul* is to separate the Blocks, to *Round In* to bring them closer together. When the blocks are in contact they are said to be *Chockablock.*

By Power of a tackle is meant its mechanical advantage, or the ratio of the force exerted by it to that applied to the Fall, or in other words, it is the *Weight Lifted* divided by the *Pull* on the *Fall.*

The actual power of a Tackle may be obtained by first computing the theoretical power.

The theoretical power of a tackle is obtained by assuming that the rope is perfectly flexible, not elastic, and that the blocks have no friction. It is (approximately) equal to the *number* of *parts*

of the *rope attached* to or *running from either side* of the *movable block,* or another simple rule is, *the force applied multiplied by the number of the moving parts equals the gaining power of the tackle.*

The above result is considerably modified in practice owing to the loss of power due to friction of the sheaves and stiffness of the rope. Under the supposition that the blocks are well lubricated and that there is no twist in the tackle, the allowance to be made for friction is *1/8 to 1/12 (an average of about 1/10) the weight for each sheave in use,* this of course depends on the kinds of sheaves and the flexibility of the rope.

By means of the following formula the actual power of any tackle may be calculated from the corresponding theoretical power:

$$P = \frac{W\,(m+n)}{mf}$$

In which P = pull on the fall of the rope.
W = weight to be raised.
f = theoretical power of the tackle.
n = number of sheaves.
$\frac{1}{m}$ = the part of W to be added for each sheave in use.

The following example will illustrate the difference between the actual power and the theoretical power of a tackle:

EXAMPLE 1. A Weight of 15,000 pounds is to be lifted by a tackle consisting of two *Treble* blocks.

Required: (a) The theoretical pull required to lift the weight.
(b) The actual pull required to lift the weight.

SOLUTION: (a) Since there are six ropes leading to or away from the movable block the theoretical power is 6.
The pull to be applied then =

$$\frac{15000}{6} = 2500 \text{ pounds (Ans.)}$$

(b) $$P = \frac{W\,(m+n)}{mf}$$

W = 15000 pounds
m = 10
n = 6
f = 6

$$\text{Pull} = \frac{15000 \times (10 + 6)}{10 \times 6} = \frac{15000 \times 16}{60} = \frac{240000}{60} =$$

4000 pounds (Ans.)

In solution (b) it requires 1500 pounds more pull to raise the weight than it would have had there been no friction, as friction and stiffness of rope represents a loss of about 60% in the pull.

Whip (Figure 1). The simplest form of tackle; it is made by a rope, rove through a single block.

Whip Upon Whip, so called where the block of one whip is attached to the fall of another.

WHIP TACKLE

Figure 1

GUN TACKLE

Figure 2

LUFF TACKLE

Figure 3

Gun Tackle (Figure 2), is made by reeving a rope through two single blocks and making the standing end fast to the upper block.

Luff Tackle (Figure 3) is made by reeving a rope through a single and double block. Inverted it is called a *Watch* or *Tail* tackle.

Luff Upon Luff. A luff tackle upon the fall of another luff tackle is so called.

Gin Tackle consists usually of a double and a treble block, but may consist of a single and a double block.

Single Burton, consists of two single blocks.

Double Burton, a single Burton with an additional whip attached to its fall, the standing part of which is also attached to the weight to be raised.

Spanish Burton, a gun tackle with a whip attached to its fall.

Double Spanish Burton, a luff tackle with a whip attached to its fall in the same manner as a Spanish Burton.

When one tackle is applied to the Fall of another the power

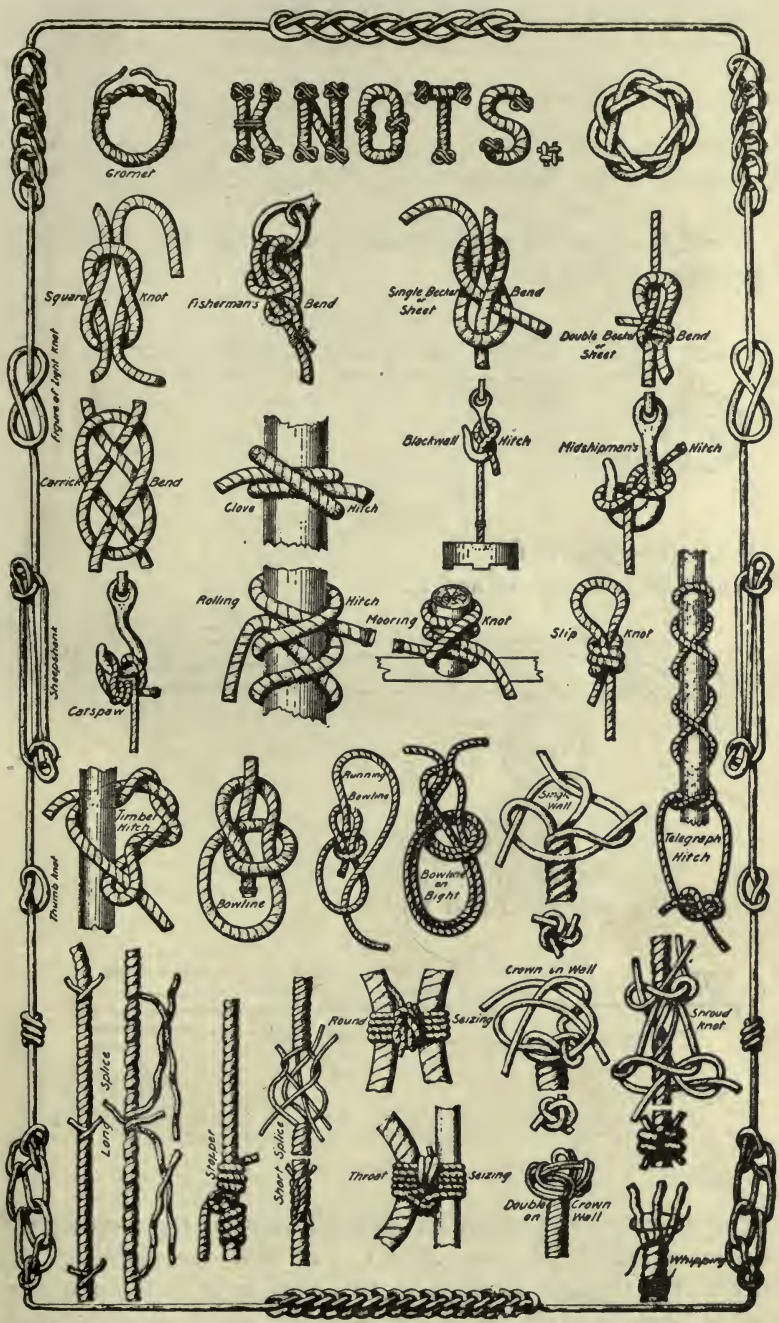
KNOTS.
Gromet
Square Knot
Fisherman's Bend
Single Becket or Sheet Bend
Double Becket or Sheet Bend
Figure of Eight knot
Carrick Bend
Clove Hitch
Blackwall Hitch
Midshipman's Hitch
Rolling Hitch
Mooring Knot
Slip Knot
Sheepshank
Carspaw
Timber Hitch
Bowline
Running Bowline
Bowline on Bight
Single Wall
Telegraph Hitch
Thumb knot
Long Splice
Short Splice
Stopper
Round Seizing
Crown on Wall
Shroud knot
Throat Seizing
Double Crown on Wall
Whipping

Figure 4

obtained is found by *multiplying their respective values together.* Example:—Luff upon Luff power equals 3×3 or power of 9.

Levers

There are three Classes, or orders, of levers, depending upon the position of the fulcrum.

1st. (See Figure 5.)

Where the Fulcrum f is between the weight W and the point of application of force P.

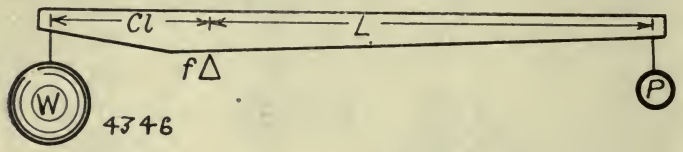

Figure 5

2nd. (See Figure 6.)

Where W is between f and P.

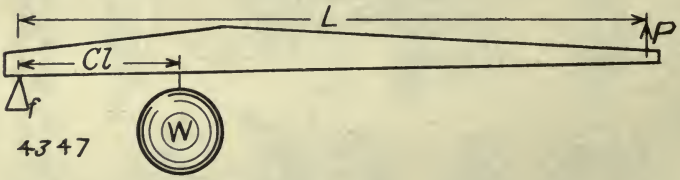

Figure 6

3rd. (See Figure 7.)

Where P is between f and W.

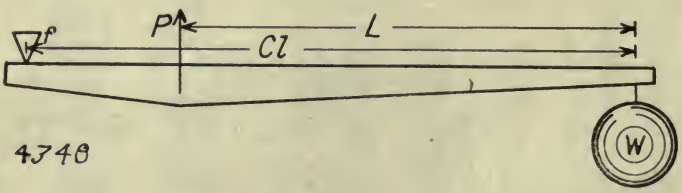

Figure 7

The distance from the point of application of the force to the Fulcrum is called the *Lever Arm L,* and from the weight to the Fulcrum the *Counter Lever Arm Cl.* This is on the supposition that the Lever is straight and that W and P act at right angles to it. Suppose now we have levers of the shape shown in Figures

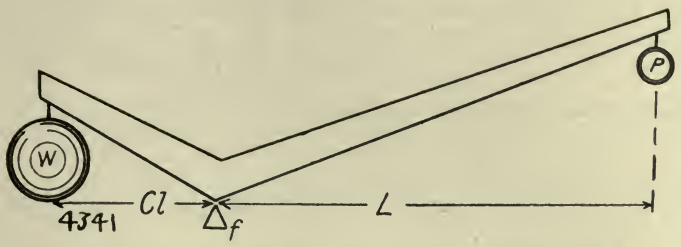

Figure 8

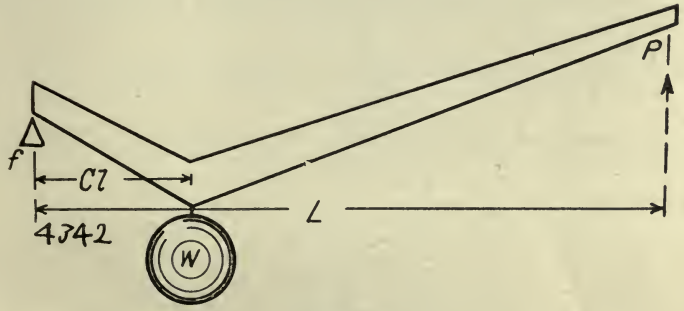

Figure 9

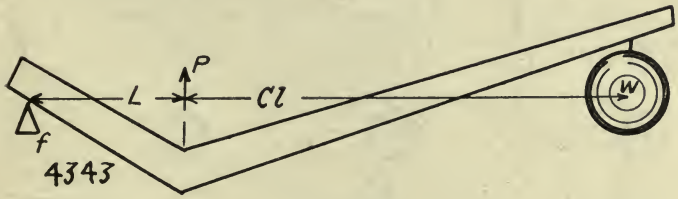

Figure 10

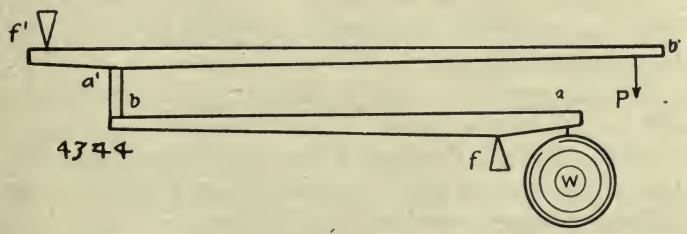

Figure 11

8, 9, and 10, then L and Cl are the perpendicular distances from f to the lines of application of P and W, where af is the counter Lever Arm and bf the lever Arm.

Lever of the first class

Example: Use of handspike as a pry.

Lever of the second class

Example: Operating lever on hydraulic jack.

Example: The hoist arm on a crane or derrick.

In each of these classes the distance from the point of application of the force to the fulcrum is called the lever arm (L) and from the weight to the fulcrum the counter lever arm (Cl).

Double Compound Lever—The mechanical advantage of this lever is $\frac{L}{Cl} \times \frac{L'}{Cl'}$ in which L and L′, Cl and Cl′ pertain to the corresponding parts of the two levers. The power of a treble compound lever is $\frac{L}{Cl} \times \frac{L'}{Cl'} \times \frac{L''}{Cl''}$.

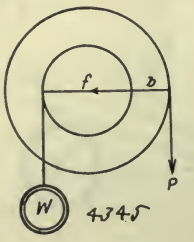

Figure 12

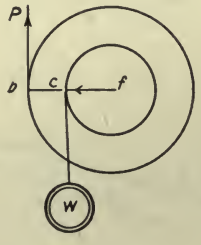

Figure 13

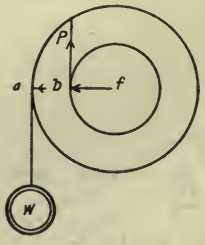

Figure 14

This variety of levers is exemplified in (a) the *Windlass of a Gin,* in which the Cl is the radius of the windlass and L the distance from the axis of the windlass to the point on the handspike where the men take hold, when raising a weight.

(b) *Capstan*—where Cl is the radius of the drum and L is the length of the capstan bars.

(c) *Crab*—this is a *Compound Lever* in which Cl and Cl′ are the radius of the smaller gear wheel, and L and L′ the length of the windlass arm and the radius of the larger gear wheel.

The mechanical advantage gained by a lever of any class may be figured from the following:

For *Simple Lever* $\frac{L}{Cl}$

For *Compound Lever* $\frac{L}{Cl} \times \frac{L'}{Cl'}$

Power to be applied $= \frac{W \times Cl}{L}$ or $P = \frac{W \times Cl}{L}$

Weight that can be lifted $\frac{L \times P}{Cl}$, or $W = \frac{L \times P}{Cl}$

THE DIFFERENTIAL PULLEY

(See Figure 15.)

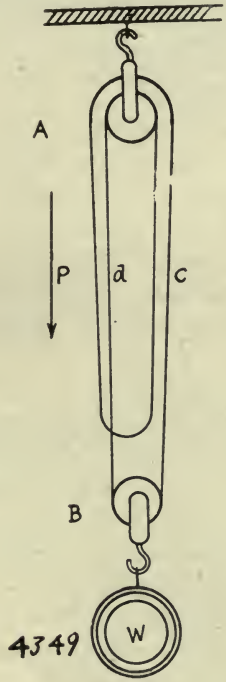

Figure 15

This machine embodies the principles of the revolving lever, combined with a single movable block.

Two pulleys of unequal diameters, having a common axle, are rigidly attached to each other; an endless chain passes round the larger pulley, A, down round the movable pulley, B, and up round the smaller pulley; the upper pulleys are sprocket wheels, that is they have projecting points or teeth in the rims into which the

links of the chain fit to prevent its slipping when a weight is supported. The weight is suspended from the lower pulley, B, and the force is applied to the chain at P.

The power of this tackle, neglecting friction, is:

$$2\left(\frac{R-r}{R}\right),$$

in which R = radius of large pulley, r = radius of small upper pulley and the factor 2 enters, as each part, c and d, of the chain evidently supports one-half the weight W.

EXAMPLE:—If the radius of the large pulley is 3 inches and of the small pulley 2½ inches, the power of the tackle will be:

$$2\left(\frac{3}{3-2\frac{1}{2}}\right) = 12, \text{ and if } W = 600 \text{ lbs., } P = \frac{W}{f} = 50 \text{ lbs.}$$

Hydraulic Jacks

Nomenclature. (See Figure 16.) There are two kinds of Dudgeon's Hydraulic Jacks; namely, the *Base Jack* and the *Horizontal Jack.* Both of these jacks are constructed according to the same principle and the method of operation is the same for both. In Coast Artillery, the horizontal jack only is used.

A *Jack* is a *lifting machine.* It is operated by means of a liquid acting against a piston to raise it; pressure on the liquid being produced by means of a pump.

A force of a few pounds, from about 50 to not to exceed 150, applied at the end of the pump handle or lever, produces a lifting force of from 15 to 60 tons against the piston of the ram.

15, 20, 30, and 60 Ton Jacks are the sizes supplied by the Ordnance Department and these jacks may be used equally well in a horizontal or upright position.

According to the principle of physics, (Law of Pascal), "When a force or pressure is applied to a fluid contained in a vessel, this force is transmitted equally in all directions throughout the fluid." Consequently if a force of 100 pounds be applied through a pipe the area of whose cross section is one square inch, to a fluid in a vessel, whose area is 100 square inches, the resultant force will equal 100 times the original force, or $100 \times 100 = 10{,}000$ pounds. This principle is made use of in the jack, for in its application to the jack, the force is applied through a small pump channel to the fluid contained in the ram cylinder. Assume the cylinder to be about 30 times as great as the area of the channel, and that there is 100 pounds of pressure transmitted through the opening of the channel to the cylinder, then the piston (which just fits the cylin-

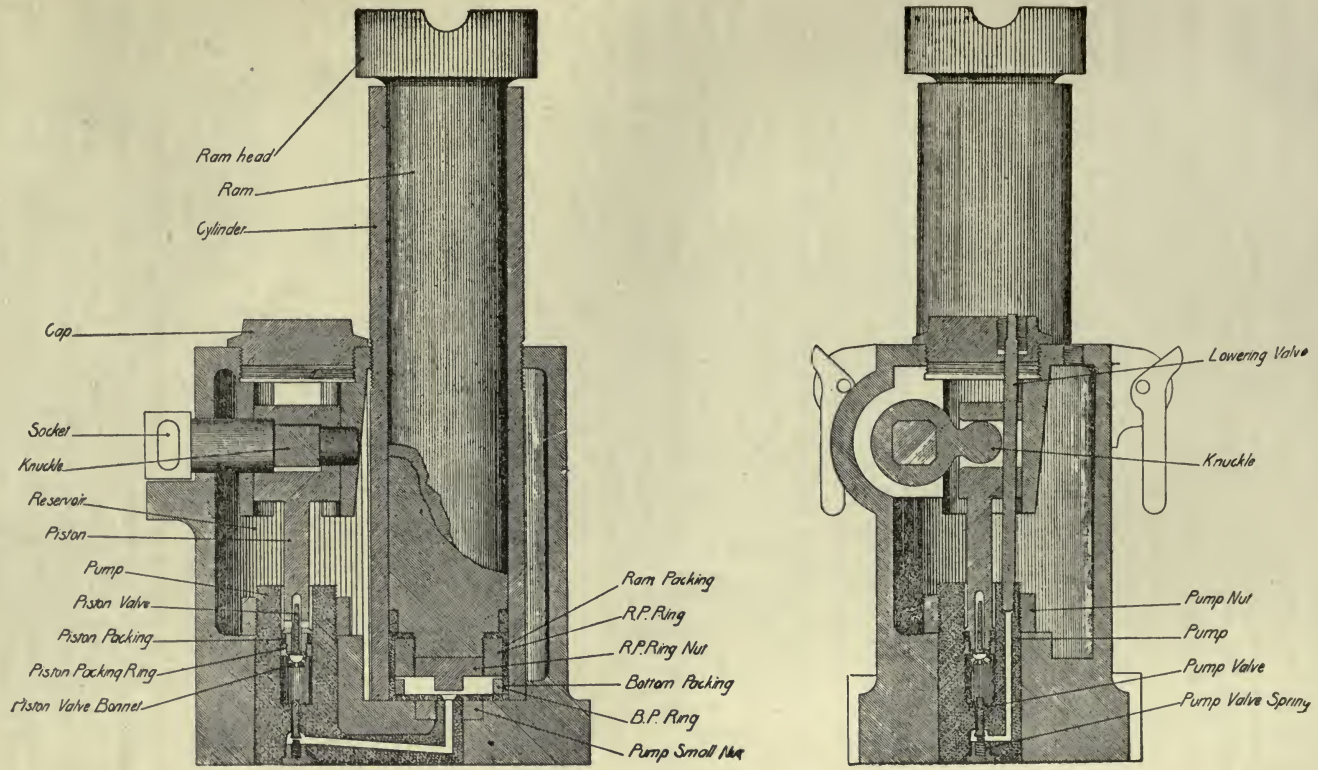

Figure 16. Horizontal Jack

der) will receive an upward pressure or push of $30 \times 100 = 3000$ pounds. In other words, the original force of 100 pounds applied through the channel to the fluid contained in the cylinder is transmitted equally in all directions in the cylinder, and on each area of the piston equal in size to the area of the channel is exerted a force, (or push) equal to the original force (100 lbs.). As there are thirty (30) such equal areas to the piston, and the fluid in the cylinder is exerting the same pressure on each of these areas, it is easy to see that the total pressure on the piston is thirty times as great as the pressure through the channel where the area of the opening of the channel is only one-thirtieth of the area of the piston.

The Hydraulic Jack makes use of still another mechanical principle. It is the lever. Examining the jack it is seen that the pivot comes opposite the end of the lever. This is called the *Fulcrum* of the lever. The weight (piston) is applied about one inch from the piston end, or fulcrum. From the fulcrum to the end of the handle of the lever where the force is applied is about 25 inches. This makes it a lever of the second class (the weight between the fulcrum and the applied force), and gives a decided mechanical advantage; as the lever arm, or power arm (the distance from the pivot or fulcrum to the point where the power is applied) is twenty-five times as great as the counter lever arm, or weight arm, which is the distance between the fulcrum and the point of the lever when the weight is applied.

The Operation of the Jack.

1. The by-pass channel is closed by screwing down the lowering valve, so that the only way the liquid can go is to the ram in the cylinder.

2. The handle of the piston is placed in its socket, with the projection downward.

3. Move the handle of the piston up and down, which produces the following results:

Motion from the lever is transmitted to the lever socket, thence to the knuckle which works up and down in a recess of the piston and forces the piston up and down in the reservoir. The down stroke of the piston closes the piston valve, and the pressure compresses the pump valve spring, opening the pump valve, thereby forcing liquid through the channel to the ram cylinder. The ram is forced up by pressure of the liquid in the cylinder against the lower end of the ram as explained above. On the up stroke of the pump piston, the pump valve spring forces the pump valve up to the closed position and prevents the return of any fluid from

the cylinder to the reservoir. This prevents the ram, supporting the weight, from dropping down as the liquid is confined and practically non-compressible. On the up stroke of the piston the piston valve drops down in the piston valve bonnet opening a passage for the fluid which flows from the upper portion of the reservoir through the two small holes in the piston and bonnet to replace the fluid under the piston which the previous down stroke of the piston has forced into the cylinder.

Instructions for Using.

1. Be sure the ram is down before filling.
2. Fill with one part alcohol (not wood alcohol) to one part water with a teaspoonfull of sperm oil to prevent the water from rusting the cylinder.
3. Care must be taken that no dirt gets into the reservoirs in filling.
4. Fill reservoir to within an inch of the top and replace the screw but do not screw up tight as an air passage is cut in it.
5. Never use water, kerosene, heavy oil, or glycerine to fill the Jack. Water is liable to freeze and would rust the jack when not in use. Kerosene destroys the packings and corrodes the metal surfaces. Heavy oils and glycerine soften the packing and gum and clog the valve parts.
6. Occasionally clean out the jack and refill it as the liquid becomes thick and the jack will not work satisfactorily.
7. Always keep the ram down when not in use.
8. To raise the weight, screw the lowering valve tight on its seat and work the lever up and down.
9. To lower the weight, unscrew the lowering valve—two turns are sufficient to lower as fast as required.
10. Use the claw or "S" hook when the jack cannot be placed under the weight.

FIELD MANEUVERS

The implements and machines required for the various operations depend upon the kind and weight of the piece and the nature of the maneuvers to be performed. For each exercise, those specially required should be listed carefully and should be on the ground before the work commences. When work is to be done, due allowance must be made for the wear and tear, which, with heavy matériel, is very considerable. *Sound discretion* should be exercised not to allow the wearing to go beyond the limit of safety.

The machines and appliances usually employed for moving heavy artillery and other heavy objects are:

Ropes, Blocks and Tackles	Derricks
Gins	Shears
Hydraulic Jacks	Blocks and Skids
Sling Carts	Chocks
Hand Spikes	Hand Carts
Railway Trucks	Way Planks
Cradles	Pinch Bars
Capstans	Collars
Tractors	Rollers

These are sufficient to manage the heaviest piece of Artillery in the cases which ordinarily present themselves in service.

The *Capstan* is used as a strong purchase in heaving or hoisting. When so employed, it is held in position by a stout chain attached to hold-fasts. The rope is passed two or three times around the barrel of the capstan, the free end coming off above the turns; the standing part is attached to the weight to be moved. The rope is drawn taut by hand, the bars inserted in the mortises, and the free end of the rope held and taken in by two men seated on the ground.

Twelve men—three at each bar—are all that can be advantageously employed. When additional power is required, the bars are swifted, that is, the ends of the bars are lashed together with ropes, by which additional men take hold.

A *Cradle* is used to carry a gun when it is being moved on rollers. It consists of two sections of Skids of suitable strength and length, connected by two cross pieces which are joined and bolted to the skids. The ends of the Skids are beveled off on the bottom to permit engaging the rollers easily. The cross pieces are hollowed out on top to receive the gun. The gun may be lashed to the cradle if necessary. When making a turn, the front rollers should be inclined in the direction of the turn and the rear rollers in the opposite direction. The rollers may be knocked into place with mauls. A body moving upon a roller gains twice the distance passed over by the roller.

Blocks are rectangular prisms of wood employed extensively in all operations connected with the movements of Heavy Artillery.

Skids are rectangular beams of wood used for similar purposes.

All Blocks and Skids should be sound, free from knots, and perfectly true dimensions. When the edges become splintered

and rounded by wear, they should be discarded, as with such timbers it is impossible to erect safe and stable cribbing and supports. They should not be painted. The thickness of each should be marked on both ends. In erecting a crib or other support, a level foundation is of the first consideration, the Blocks should then be laid crossing each other in alternate tiers, and the weights supported should be made to bear equally upon all sides of the base.

The *Way Plank* is an oak plank 15 feet long, 12 inches wide and 3 inches thick. Each end is beveled for a distance of 6 inches, the bevel on one end being on the side opposite the bevel of the other end. These Planks are used chiefly for forming temporary tramways for rollers, or for the wheels of carriage bearing heavy weight.

The *Pinch Bar* is simply a stout handspike, or iron, with a round-beveled butt, turned up into a blunt edge for the purpose of catching under a gun or other similar object. It is used as a lever, by pressing down, thus jumping the gun forward a very short distance at a time. The butt end is of steel. The length of the bar is from five to seven feet.

The *Collar* is a device placed upon the chase of a gun to make its diameter equal to that of the body of the piece. This enables the gun to be rolled with facility. It is made of pieces of scantling joined together after the manner of the staves of a cask, and hooped with stout bands of iron. It is shoved over the muzzle onto the chase, and secured with wedges of wood.

Chocks are made of solid oak wood, of various shapes and dimensions, those of triangular cross section being most common. The grain of the wood runs lengthwise with the chock.

All implements and machines before being used, should be most carefully examined in every detail, to see that they are serviceable and suitable for the operation to be performed. None should be put to uses for which they are not intended, nor subjected to strains they are not constructed to bear.

It must be borne in mind that the giving away of one part breaks and destroys other parts, frequently to an extent not readily repaired, and, furthermore, endangers those working at the maneuvers. Heavy weights must never be allowed to drop, even for the shortest distances; they must be lowered to rest with a gentle motion, and at the same time chocked to prevent rolling or sliding. In hoisting, they must, when practicable, be closely followed up with blocks or chocks to guard against any possible giving way. All motions with heavy bodies must be slow, so as not to generate momentum. Supports must have a firm base, and cribbing a level

foundation, and be built up vertically. All holdfasts must be secure beyond possibility of giving away.

Two or more men, lifting or hauling together, must wait for the command before exerting their strength. The officer in charge sees that all are ready before giving the command *HEAVE*. Then all move with a prompt but steady effort, and apply their power increasingly until the weight responds to their effort. The command will be repeated as often as it may be necessary. When the movement has been sufficiently made, the command EASE AWAY is given. Those making the effort will then desist; but at all times will be careful to avoid all sudden shocks or strains. Every operation should be done with spirit and animation, but without bustle or confusion. Vigilance should be constantly exercised to have the piece or rollers securely chocked.

When lifting a gun with Jacks, be sure and lift one end of the gun at a time, the other being chocked on the cribbing.

A greased steel rail on top of a Skid will greatly facilitate sliding a gun or slueing the trunnions.

The Handspikes used in mechanical maneuvers are beveled on one side, as these will enter into places or under bodies where square handspikes could not be used. When a handspike rests on a fulcrum, and the weight on one end is to be raised by bearing down on the other, the weight should never rest on the beveled side, as the handspike would not then give a good hold, and would be liable to split. In this case the beveled side should be down, but if used for lifting, as when two handspikes are crossed under the breech or chase of a gun to heave it upward, their ends resting on the ground or platform, the beveled side should be up.

Parbuckling is the best method of rolling a gun. To do this, place the gun on skids, and attach the rope by a bowline to one of the trunnions, passing it under and around up over the gun, and hauling on the end. If the gun is to be rolled up a slope, two ropes of size suitable to the weight of the gun, are used. An end of each rope is made fast to some fixed object at the upper part of the slope; the other ends are carried under the chase and body respectively, and up over the gun, these ends are hauled upon by means of a capstan, or by attaching to them a fall and tackle. The muzzle is slued forward when necessary, to compensate for the greater distance traveled by the breech.

To *Cross-Lift* a piece or other object is to cross handspikes under it from opposite sides. The butt end of the handspikes is on the ground, and the power is applied by lifting at the other end.

To *Slue the Trunnions* is to turn the piece on its axis so as to bring the trunnions into any required position. This is done by first placing the piece on skids perpendicularly to its axis. A fulcrum is placed near the trunnion to be raised; upon this a handspike or other lever is used, the piece meanwhile being chocked on the opposite side, or a trunnion loop may be placed around the trunnion to be raised, and a handspike or lever passed through it, with the butt end resting on the top of the piece, the power applied by lifting at the other end, the piece being chocked as before. Or, by passing the bight of a rope once or twice around the piece and placing the butt of a handspike or lever through the bight, and bearing down or lifting up, using the piece as a fulcrum, the ends of the rope being held to prevent them from slipping. All three of these methods may be used at the same time. The skids should be well greased under the piece, and likewise should be the chocks. When the piece is of great weight, the hydraulic jack or gin is advantageously used, provided, the axis of the trunnions are not vertical. The former is placed under and the latter over the trunnion to be raised. When the axis of the trunnions is vertical or nearly so, a rope is passed around the gun and made fast to one of the trunnions in a manner similar to the parbuckling arrangement and hauled upon with tackle; meanwhile keeping the gun from rolling with greased chocks. The chock may be kept in place by passing a rope around its end, under the gun along each slide of the skid and making fast around the end of the skid.

To *Pinch* a gun or other object is to move it by small heaves with a pinch-bar or handspike, without allowing it to turn on its axis. A piece is pinched one end at a time, the other being chocked. The bar or handspike is placed as a lever, with the beveled side down, and the power applied at the other end by bearing down.

To *Launch* a piece or other object forward or backward is to move it in the direction of its axis. If the weight is such as to require levers or handspikes, they are placed, usually, on opposite sides, and the power applied by bearing down, at the same time carrying the free end of the lever in a direction contrary to that in which the object is to be moved.

To *Slue* a piece or other object, end for end, is to turn it around, not allowing it to revolve on its longer axis.

The muzzle may be slued by pinching it along skids, or by placing a roller or skid in the muzzle and hauling upon it with tackle. Probably the best way of slueing the muzzle of a heavy gun, is by means of a hydraulic jack and greased chock. Jack up the muzzle until the inclined edge of the chock can be placed well

under. Lower away on the jack, keeping the chock firmly in place and allowing the muzzle to slide down its edge and onto the skid. The jack will incline to one side and should be steadied to keep it from falling.

To *Cut* is to move the object horizontally, without rolling, by moving each end alternately in the required direction.

Use of Tractor

Occupation of Position by Tackle

The occupation of position by tackle would only arise when it was desired to keep the tractor on the road so as to avoid making tracks which would destroy the concealment of the position or when the position is so narrow that the tractor cannot go ahead of the gun and put the latter in its position. With Wheeled Tractors, this method is used not only to avoid making tracks, but also because frequently the soil is too soft and heavy to permit of the tractor entering the position.

With any type of Tractor, this method necessitates the use of a holdfast for the block of the tackle at the position. Holdfasts may be available in the form of the walls of a standing or ruined building, trees, etc. A tree should only be used if well grown and sound. The strap should be placed as near the butt as possible and still keep the ropes of the tackle off the ground. The excellence of the following trees as holdfasts in general is in the order named: Oak, Beech, Chestnut, Willow, Birch.

The best artificial holdfast is the *Deadman.* Dig a cross trench at least five yards beyond the battery position, one yard and a half long, twenty inches wide and one yard deep. At right angles to its middle point dig an inclined trench to the bottom for the strap of the tackle. Place a plank one yard and a half x 12″ x 3″ on edge at the bottom of the trench on the near side, then drive in four stout stakes behind this plank. Now drop in a log or timber about 12″ in diameter, with the strap around it, behind the four vertical stakes; drive four stakes obliquely into the rear side of the trench, bearing on the log; then drop into place between the near wall and the vertical stakes another plank one yard and a half x 12″ x 3″.

The kind of tackle to use generally depends more on the strength of the rope than on the power of the tractor. In general, with good rope, the luff tackle is sufficiently powerful. With extremely soft ground or on a steep slope, depending on the kind of gun, the four-foul tackle, two double blocks, or the five-fold tackle, a triple

block and double block, may be required. Always err on the side of choosing too powerful a tackle.

Safety Tackle. Whenever the gun has to be moved up or down a very steep slope, a safety tackle of equal strength with the maneuvering tackle should be reeved and attached to the gun and made fast to a separate holdfast. The fall may be led to any convenient and secure means of snubbing it. One or more men should be detailed to handle this tackle. If the gun is being raised, the safety tackle should be rounded in constantly to keep it taut, the fall being snubbed the while. If the gun is being lowered, the safety tackle should be paid out to keep pace with the movement of the gun. Or the second tackle may be led to the pintle of another tractor, and thus become a power tackle.

Use of Power Other Than the Tractor. The maneuver of guns or other heavy vehicles may be accomplished by the use of tackle according to the above principles with either horse-draft or man-power on the fall. For the execution of difficult slow movements horse-power is not satisfactory. With the size of rope ordinarily furnished, not over forty men should be put on the fall of a tackle in situations where the breaking of the rope would endanger the gun. With the use of large cable, 200 men have been used effectively on the fall of a tackle.

Crossing of Ditches. Ditches should be bridged by heavy planks or filled with fascines.

Very Soft or Muddy Ground. Should be crossed by the use of mats or by laying heavy planks crosswise for the wheels to run on.

Use of Tackle With the Holt Tractor

The Holt Tractor not being provided with a capstan, the fall of the tackle is handled by making it fast to the tractor, which then moves off the desired distance, the fall being cast off and the tractor backing up when necessary for a new hold. A man should be detailed to the fall, making fast to the tractor pintle by a blackwall hitch and retaining the free end in his hand. Another man should be detailed at the holdfast, to keep the block straight and the rope clear.

If it is desired to keep the tractor on the road it will generally be necessary to change the direction of the fall by the use of a snatch block on a second holdfast. For this holdfast it may be convenient to use another Holt tractor, particularly if the change of direction is not too abrupt.

Simultaneous Maneuvering of Guns. The time that the guns are occupying or leaving a position is generally a most critical

period for the safety of the Battery. Therefore every means should be taken to shorten this period. Whenever the approach to the position will permit the simultaneous maneuvering of the guns, the work should be planned so that all guns may be put into position by their own tractors simultaneously, even if it is necessary to install a deadman for each gun. Sometimes it will happen that one or more guns may be put in position by direct traction while the others are being put in by tackle.

Use of One Holdfast for More Than One Gun. It will frequently occur that a suitable natural holdfast is not on a line through any one gun position at right angles to the battery front. However, by starting each gun from a position on the road such that a line from the gun to the holdfast will cross the gun position, such a holdfast may be made to serve for two guns.

Use of Two Holdfasts for One Gun. On other occasions no one natural holdfast will lead a gun to its position, but by leading one or more parts of the tackle to another block at a holdfast situated at a distance on the other side of the direct line to the position from which the first holdfast is located, it will be possible to haul the gun and direct it to its position. The influence on the steering of the gun of the number of parts of the tackle led to each holdfast must be considered.

Handling Artillery in Mountainous Country. This is a subject which deserves special consideration. There are conditions of Alpine warfare which require the emplacing of guns in almost inaccessible places. To emplace the guns and also to maintain their ammunition supply, resort has been had to aerial cableways and other complicated and extensive use of cordage and tackle which is outside the scope of the contemplated work of Tractor Artillery. However, in order to fulfill its mission Tractor Artillery may need to emplace its guns in very difficult positions. In order to meet these conceivable situations, it is first of all necessary to accept as a fundamental principle that given the necessary time and equipment, any tractor weapon can be emplaced anywhere. The *Practical* applications of this principle by the limitations imposed by the tactical situation upon the *Time and Equipment* to be used in consideration of the object to be attained, ordinarily results in the selection of very easily accessible positions for Tractor Artillery.

Negotiating a Bad Turn on a Mauntain Road. If the turn is so sharp as to preclude the tractor or tractors making the curve with the gun attached, it may be possible to uncouple the tractor, run it round the turn, and then draw the gun around the turn with tackles. For the first pull, it may be necessary to carry the rope

from the gun through a snatch block at a holdfast on the upper side of the road. Then after the gun has completed part of the turn the rope may be released from the snatch block for a direct pull. If the turn is so abrupt that the gun alone cannot negotiate it, there are still two recourses. 1st: the road may be widened. If the soil is such as to make this difficult, haul the gun directly up the slope from the lower reach of the road below the turn to the upper reach above the turn. To do this, select three stout trees above the upper road for holdfasts, or install deadmen. Rig two heavy maneuvering tackles and one safety tackle. Run the tractor or tractors hauling the gun around the curve and up out of the way. Attach one maneuvering tackle to the limber, not to the draw-bar, and carry its fall through a snatch block at a holdfast on the lower road, back of the gun, to the tractor following. Attach the second maneuvering tackle to the Gun Carriage proper, leading its fall similarly through another snatchblock to a second tractor on the lower road. Attach the safety tackle to the limber. Using both maneuvering tackles, haul the gun up the slope, turning and steering it by slings tied to the drawbar, leading to either side, with the necessary number of men, 6 or 8, on each sling. After the limber wheels surmount the edge of the upper road take most of the strain on the tackle to the carriage itself, so as to facilitate steering the gun into its position on the road. The fall of a tackle should never be led directly to a tractor on the upper road, as the sudden failure of a holdfast might drag the tractor off the road before the tackle would yield to over hauling.

Emplacing a Gun in a Position With Steep Approaches. In general it may be said that even if there is a road of suitable gradient to the position, if this road is not amply wide with practicable curves, it is safer to handle the gun by tackle, by the means indicated in the preceding paragraph. The important point to observe is that the gun must be handled *Straight Up* the slope. Only by this means can it be kept bearing on its wheels and avoid overturning sidewise.

Lowering a Gun Down a Steep Slope. The three tackles should be made fast to the gun carriage and the gun lowered, limber first. The man steering the limber should use slings long enough so that they would not be caught by either the gun or tackle in case of accident. Here again the important thing is to avoid any tendency for the gun to overturn sidewise by keeping it headed straight down the slope, thus providing equal bearing for all the wheels. As an additional precaution, the falls after being led away from the tractor, should be snubbed around a

tree, and an additional man detailed to keep the fall paying out freely at the tree, but ready to snub it instantly when directed.

Rescuing Mired and Overturned Vehicles. If a motor vehicle becomes mired, chains should be put on if not already on, and in using its own power, the motor should not be accelerated excessively. Opening the throttle wide generally serves merely to spin the wheels, digging a deeper hole for the machine to drop into. By using the clutch carefully, it is often possible to get traction by short grips, without stalling the motor or digging deep holes.

A vehicle which runs or slides partly off the road should always back out rather than try to go ahead and steer up onto the road. If there is another machine behind, it should give a tow, even if only a light car. The towline should be made fast to the frame rather than the front axle, and if possible, should be ten yards long.

A vehicle which has overturned should first of all be unloaded Then if the ground is soft and the vehicle is heavy, planks should be placed under the lower wheels and the brakes set. If jacks are available, one should be used under either end as far up on the body as the strength of the body will permit. Follow up the work of the jack with blocking, improvised if necessary, and when the jack has reached its limit, give it a new footing with blocking. Before the vehicle raises high enough to right itself, secure it by a guy rope so that it will not right itself with a crash, either snubbing the guy rope or using men on the fall. Or a shear may be rigged. A light car or truck may be righted by the effort of the number of men who can assemble around it. In any event, whatever means is used to lift the vehicle, all men available should bear a hand, using improvised levers if possible.

THE GIN

A *Gin* is a tripod formed of three poles. Two of these poles called legs, are joined together by braces of wood or iron and contained between them the *Windlass.* The third pole is called the *Prypole,* and is joined to the *Legs,* at the top, by a bolt. This bolt supports a *Clevis* to which the upper block of the tackle is hooked.

The *Windlass* is worked by two handspikes fitting into brass sockets, one at each extremity of the windlass; the operation of the handspikes is made continuous by the action of a *Pawl* attached to the socket on the *Ratchet* of the windlass.

The Prypole has cleats nailed to it to enable a man to mount to the head of the gin to hook on the block and to reeve the fall.

To prevent the legs and prypole from sinking into the ground, or injuring the pavement of casemates, stout pieces of wood, called *Shoes*, are placed under them.

GARRISON GIN

The *Hoisting* apparatus consists of two blocks, through which the fall is rove. The fall is wound two or more times around the windlass.

There are three kinds of Gins used for Artillery purposes, the *Siege*, the *Garrison*, and the *Casemate*.

The last two differ from each other only in height; the first differs from the others in construction and size. *Piper's Gin* is an improved modification of the *Siege Gin*.

Figure 17. Garrison Gin

The *Siege Gin* (Old pattern) has no *Clevis*, as other gins, instead of an upper block, two *Sheaves* are inserted between the legs and secured by the bolt holding together the legs. The head of the prypole is terminated by a flat piece of iron, which fits between the heads of the legs above the sheaves and is secured by another bolt.

This gin further differs from others in having three wooden braces instead of two of iron. It has the disadvantage of being exceedingly ill-contrived and unhandy.

The *Garrison* and *Casemate Gins* differ from the siege gin in having two cross-bars, and in having the prypole inserted between

the legs, which are kept together by the *Clevis Bolt.* The upper block (generally treble) is hooked to the clevis.

The casemate gin is made shorter than the garrison gin, so that it may be hoisted in casemates.

When the gin is put together and raised, that part included between the legs and the prypole is called the inside, the outside being the part without the legs; the right corresponding to the right hand of a man standing at the middle and outside of the windlass, facing towards it.

The detachment is composed of 1 sergeant, 1 corporal, and 10 privates. The odd numbers are placed on the right and the even numbers on the left side of the gin, all facing inwards. Nos. 1 and 2 opposite and one yard outside of the foot of the Prypole; No. 9 outside of and near the foot of the right leg; No. 10, outside of and near the foot of the left leg; Nos. 3, 5, and 7 are between Nos. 1 and 9, dressing on them and dividing the intervening space into equal distances; Nos. 4, 6, and 8, occupy similar positions with respect to Nos. 2 and 10. In assembling the Gin the Corporal and Nos. 1 and 2 bring up the prypole; Nos. 3, 5, and 7, the right leg, and Nos. 4, 6, and 8 the left leg; Nos. 9 and 10 the windlass. The Corporal superintends putting together the head, and the Sergeant the placing of the windlass. The braces are brought up and adjusted to their places by Nos. 4, 6, 7, and 8.

All except the old pattern *Siege Gin* are put together and hoisted by raising the head and bringing up the foot of the prypole towards the foot of the legs.

The gin may be put together across the piece, or on the ground near it, lying extended in the form of a *Y* with the inside down.

The gin being together and lying on the ground, the Sergeant commands *RAISE THE GIN.*

In raising it Nos. 9 and 10, each with a handspike, brace against the lower cross-bar near the legs to prevent them from slipping; Nos. 1 and 2 hold down the foot of the prypole, and at the same time push up by the handle. The remaining numbers take hold to lift by hand near the head.

The Corporal commands *HEAVE,* the head of the gin is raised as high as the men can lift, and the prypole is pushed up; Nos. 3 and 4 go to the assistance of Nos. 1 and 2 at the handle of the prypole; Nos. 5, 6, 7, and 8, lift the legs on their respective sides. The command *HEAVE* is repeated until, by successive efforts, the gin is raised. The prypole should be for the garrison gin, about seventeen feet from the legs; for the casemate gin, about thirteen feet.

The gin is next placed over the piece by moving the legs and prypole each a short distance at a time. To prevent them from spreading too much, a lashing is passed from the prypole to the legs or to the cross-bar.

To *Reeve the Fall,* fasten one end of a trace rope to the upper block by passing it through the shell of the block. An expert man ascends the prypole to the head, and passes the free end of the rope through the clevis, from whence it is carried to the ground. By heaving on the rope, the block is raised and the hook passed through the clevis, with its point towards the prypole. The fall is rove as explained for any tackle. The upper block may be hooked to the clevis and raised with the gin; the fall may also be rooved and the whole raised together. The extra weight thus given makes the gin more difficult to lift.

The Corporal assisted by the most expert Privates, slings the piece, and attends to all knotting and lashings.

In working the windlass, Nos. 1 and 2 hold on to the fall and take up the slack; Nos. 7 and 9 work at the right, and Nos. 8 and 10 at the left handspike, Nos. 7 and 8 being next to the windlass.

To move the gin Nos. 1 and 2 station themselves at the handle of the prypole; Nos. 9 and 10 each place a handspike under the windlass from without, and near the legs; Nos. 7 and 8 assist to lift these handspikes from within; at the command all move in the direction indicated.

The gin is lowered in a similiar manner, but by inverse means to that prescribed for raising it, by gradually drawing out the prypole until the men can get near enough towards the head to support it; it is then lowered upon the piece or on the ground; as the case may be.

A gun may be moved horizontally with the gin by moving the head of the gin two or three feet in the direction in which the gun is to be moved. By hauling away on the windlass the gun may be made to slide along the skids until it is directly under the head of the gin. This operation may be repeated until the gun is in the desired position.

The lifting capacity of the garrison gin is 17,000 pounds.

A *Gin* may be improvised by lashing three timbers together and erecting them in the form of a tripod. The lashing is made as follows: Mark on each spar the distance from the butts to the center of the lashing. Lay two of the spars parallel to each other with an interval a little greater than the diameter. Rest their tips on a skid and lay the third spar between them with its butt in the opposite direction so that the marks on the three spars

will be in line. Make a clove hitch on one of the outer spars below the lashing and take eight or nine loose turns around the three. Take a couple of frapping turns between each pair of spars in succession and finish with a clove hitch on the central spar above the lashing. Pass a sling over the lashing and the tripod is ready for raising.

SLING CART

The *Sling Cart* is used for moving guns or other heavy objects short distances.

There are two kinds: The *Garrison Sling Cart,* for the heaviest weights, is attached by its pole to a limber, or on the *Hand Sling Cart,* and may be drawn by horses; the *Hand Sling Cart* is designed for moving lighter weights by hand.

With the hand sling cart the weight is raised sufficiently from the ground to transport it by first attaching a sling of the proper length to the weight to be moved and then raising the pole of the cart enough to permit the hook on the rear of the axle being hooked into this sling. The pole in this case is used as a lever, the axle and wheels form the fulcrum, and the weight is raised by lowering the end of the pole. It may be used for transporting any weight up to 6000 pounds.

With the garrison sling cart the weight is raised by first attaching to it a sling, and then applying to the sling the hooks forming the lower part of a powerful screw passing up through the axle of the cart. Above the axle is the nut of the screw, provided with long handles by means of which the screw is run up, thus raising the weight.

The sling cart is capable of supporting 20,000 pounds.

SHEARS

Shears consist of two parts of suitable size for the weight to be raised, lashed together in the form of an inverted *V*, suitably guyed and inclined slightly from the vertical. They are generally used for lifting heavy weights over the edge of a cliff or wharf, in which case only rear guys are used. Weights may be moved horizontally by manipulating the guys so as to change the inclination of the shears. They may readily be improvised from the trunks of trees, etc., when no maneuvering matériel is on hand except rope and tackle. A capstan is generally used in connection with shears, although a windlass may be improvised as explained later. All shears are constructed on the same principle.

The *Spars* when lashed in the form of shears are called the *Legs.*

The upper and lower ends of the spars are respectively called the *Head* and the *Heel,* and the part where the lashing is applied is called the *Cross.* Timbers placed under the heels to keep them from sinking in the ground are called *Shoes.* The heels are kept from slipping by *Heel Lashings* which are hitched to *Heel Posts* on either side of the heels. Heel cleats which are spiked to the spars, keep the lashing from slipping up.

The *Guys* are usually fastened to the head by slings into which one of the blocks of the guy tackle is hooked. When no guy tackles are used, a bowline in the end of the guy serves the same purpose. The upper block of the pain tackle is hooked into the ends of a sling laid between the spars above the cross. A snatch block hooked into a short sling laid around one of the spars under the heel cleat, serves to change the direction of the fall when it is run back to the capstan.

The stores necessary to equip a pair of shears are:

Guy Tackles—Two single blocks, two double blocks.

Main Tackle—One double block, one treble block, and one snatch block.

Cordage—Main tackle fall, 100 fathoms 3 to 5 inch manila rope; guys, 50 fathoms 3 to 6 inch manila rope; head lashing, 10 fathoms 3 to 4 inch manila rope; heel lashing (two each), 10 fathoms 3 to 4 inch manila rope; contingencies, 50 fathoms 3 to 4 inch manila rope.

Straps—Main tackle, one fathom 6-inch manila rope; snatch block, one fathom 4-inch manila rope; holdfasts (six), each made of one fathom 4-inch manila rope; Contingencies (six), each made of a half fathom of 4-inch manila rope. Spun-yarn for mousing, stops, etc., one ball of 100 fathoms.

Two Cleats for heels, to prevent the lashing from slipping up, made by cutting lengthwise, diagonally, a piece of 6 by 6 scantling 2 feet long. These cleats are spiked to the heels 6 inches from the bottom. Twelve stakes for holdfasts for guys, 6 feet by 6 inches; four stakes for heel posts; two shoes for heels, 6-inch plank, 1 foot by 4 feet.

To Rig the Shears, lay the ends of the spars on a trestle about three feet high, the right leg above the left, so that they cross, at about twice their thickness from the ends, with the heel in their proper position.

Pass the head lashing as follows: Take a good piece of 3½ or 4 inch rope, well stretched, middle it, and make fast to the shear leg, below the cross; with one pass the requisite number of figure-of-eight turns around both spars, heaving each turn well

taut, and hitch the end of the upper part of the shear leg; with the other end pass riding turns around both legs, filling up the intervals between the first turns, come up with the hitch of the first end, and pass frapping turns around all parts of the lashing between the shears, finish with a square knot, and stop the ends back with a good spun-yarn stop. If necessary tighten up with wedges.

It may be done in another way as follows: The two spars for the shears are laid alongside of each other with their butts on the ground, the joints below where the lashing is to be, resting on a skid. A clove hitch is made round one spar and the lashing taken loosely eight or nine times about the two spars above the hitch, without riding. A couple of frapping turns are then taken between the spars and the lashing is finished off with a clove hitch above the truns.

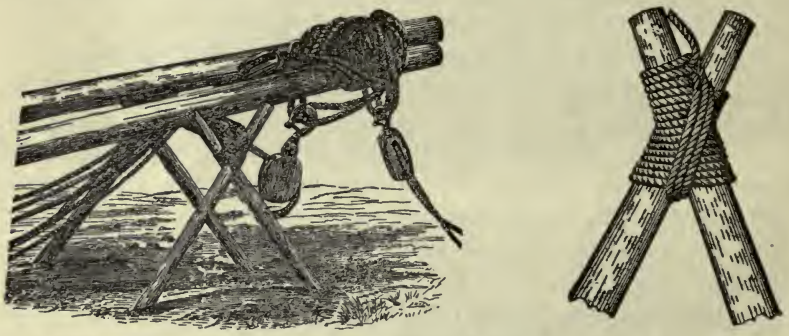

Figure 18. Shear Lashing

If *Guy Straps* are used, they can be put on doubled as follows: Middle the strap, for the back guys, which should be about the same size as that mentioned above and about 15 feet long when doubled, having the splice at the side, so that it cannot enter into either bight; lay the middle between the spars above the cross. Each end is then led in opposite directions, around the spar farthest away from the guy for which it is intended, and the ends brought back around both spars crossed ready for the guy blocks to be hooked into and moused. The strap for the fore guy is put on, doubled in the same manner around the end of the spars, and thus the strain of either and all guys tends to bind the spars together.

If the straps are used singly, they can readily be put on by raising the heels or butts and slipping them up the spars, each strap on that spar farthest away from the guy for which it is intended, the straps crossing in the crotch and led to the blocks.

If straps for the back and fore guys are not used, the back guy is arranged as follows: The back guy, a good manila rope of 3 to 6 inches, depending upon the weight to be raised, and of convenient length to 50 fathoms, is middle, and the middle placed above the cross, the left-hand end leading downward, bring the left-hand end up around the end of the right leg, then between the legs and around the head of the left leg, and carry it over to the left side of both legs; carry the right-hand end around the left leg, under the right leg, up the left side of both legs and across the left-hand end, seize the crossing with spun-yarn, the ends of the guys leading to the blocks opposite the sides of the cross from which they come.

In the case of a single back-guy, particular care must be taken to bring the axis of the shears in the vertical plane containing the holdfast and the center of gravity of the weight to be lifted.

The Main Tackle Strap or Sling, when these back and fore guys are used, is put on over the cross, passing over the whole of the straps, except the bights of the back and fohre guy straps.

The main tackle strap is put on as follows: Place the middle of the strap doubled, which for the heavier purposes is a six inch Manila rope of sufficient length, under the cross above the fore bring the ends up over the cross above the fore guy, then down underneath; hook the upper block to them under the cross below the fore guy and mouse the hook, taking care that the splice or knot does not come in the middle of the strap and that the fall leads to the rear. Or the main-tackle strap, if used singly, can be put on by raising the heel or butt and slipping it up one of the spars, and putting it in the cross over the head lashings and other straps; its bight, which should be fitted with a thimble, should hang low enough to enable the upper block of the main tackle to swing clear between the spars when raised. Should it be required to shorten it, one or more turns are taken with the strap around the head of the spars.

Two cleats are spiked to the heels, 6 inches from the ends. Lay the shoes under the heels. The shoes should be on the same level, and in bad ground, prevented from sinking or slipping by placing planks, brush-wood or other matériel underneath, securing them by pickets. Drive the heel posts or stakes, two for the lighter weights, one on each side of each leg, about a foot toward the head, and one foot outside; make a timber hitch around the inner posts with the heel lashings, pass three turns around the leg below the cleats, and hitch the lashings to the outer posts. For the heavier weights four pickets should be driven for each heel, one

at each angle and outside of the shoes, a clove hitch is made with the center of the ropes around each foot below the cleats, and the ends led to opposite holdfasts. As many turns are taken around the heel posts as may be necessary, the running ends being brought below to prevent their jamming as the shears rise.

Drive four holdfasts for each back-guide as fallows: Two on each side, three feet apart in a line of the legs prolonged, at a distance from the heels twice the length of the spars from the heels to the crotch, and two more stakes six feet in rear of these.

Lay the bight of a strap for holdfasts over the front stake; connect each pair of front and rear stakes with a strap twisted up taut to insure the strain being distributed over all the stakes; drive two stakes for holdfasts for the first guy, one in rear of the other, in the prolongation of the axis of the shears at a distance from the heel twice the length of the spars from the heels to the crutch. The length of the guys should be about four times this distance.

Hook the upper block in the end guy tackle to the bight of the strap, and the other block to the holdfast strap, which is over the front stakes; mouse all hooks. If stakes are not driven for holdfasts, any convenient hold can be taken around a tree, gun or pintle.

Ordinarily the fore guy can be worked without a tackle, belaying it over the holdfasts, first taking a round turn over the one next the shears.

If not too heavy, the shears may be raised by lifting the head and hauling on the guy tackles, slacking the heel lashings as required, and tending the fore guy carefully to prevent the shears falling over toward the rear.

When raised, hook the snatch block to a strap placed below the cleat on the leg on that side from which the fall leads, placing the block as low as possible, so that the fall will lead horizontally to the drum of the capstan.

If the shears are too heavy to raise in this way, bring both guys together at the heels; form a crutch by lashing together two poles (or use the legs of the garrison gin); place the guys in this crutch; pass the end of a small rope over both guys, in front of the crutch, down under the lashing, and take a rolling hitch with it around one of the guys in rear of the crutch; haul the rope well taut, and secure it to the lower end of the crutch leg.

Raise the crutch with an inclination of one-sixth to the front, and heave up the shears by the guy tackles. When the crutch ceases to act, slack it to the ground by the small rope.

In general the inclination or rather rake of the shears should not exceed twenty (20) degrees, or four-elevenths of their height, and each leg should have about one-half of this inclination. In this position the strain on the guys will never exceed one-half the weight.

The shears are lowered by slacking the guys and heel ropes, or by small shears or lever.

The following diagram will serve as a guide in placing shears, holdfasts, etc.:

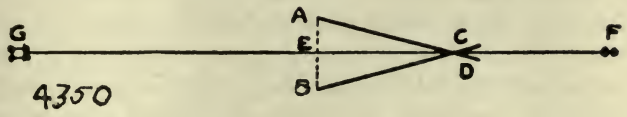

Figure 19

AD and BC are the legs of the shears.
F, the front guy holdfast.
G, the rear holdfast.
E, the center of the line AB, at right angles to FG.
AD = BC
The splay, AB = 1/3 CE.
FF and EG = at least 2 AC.

The lashing to be twice the thickness of the spars from the ends. When two fore or two rear guys are used, the holdfasts should lie in prolongation of the legs, at a distance equal to EG and EF.

When the locality will not admit of rigging the shears in position as described, they may be raised from the foot of the wall or cliff by means of a gin or lighter shears in the following manner: Pass the shear lashing and attach the front guy; lash a stout spar across the legs about two feet above the center of gravity, giving the heels the proper spread; fasten a small rope to each heel to serve as guys; hook the gun tackle to a strap firmly attached to the middle of the cross-spar, and heave away, tending the guys carefully. As the head of the shears comes above the crest of the wall, put on the back guys and main-tackle strap and hook on the tackle; mouse all hooks; raise the shears, place the heels on the shoes, pass the heel lashings, set up the guys, and lower the gin to the ground, leaving the spar in position.

When no capstan is availible, a windlass may be improvised as follows: Nail a strong cleat on the upper side of each leg and about two feet from the heel, the butt, or square end of the cleat

down; lay a round spar a little more than one-third the length of the shears across the legs, one foot above the butt of the cleats; pass loosely two strong lashings (3-inch rope) around this spar near the ends or near where it rests on the legs; frap the lashings near the spars, and tie the ends. The lashing should be loose enough after frapping to leave loops to pass over and under the butts of the cleats, taking care to have them of equal length. Grease the spar and legs where they are in contact, and the spar under the lashing. Pass two or more straps of 1½ or 2 inch rope doubled around the end and middle of the spar, put one end through the bight of the other and take a turn around the spar. Put a handspike the free bight, to be used as a lever to turn the windlass.

These straps should be nailed to the spar to prevent slipping.

The windlass is chocked by allowing two or more handspikes to touch the ground on the opposite side of the windlass.

Light guns may be passed over ditches or from different places practically at the same level, but too far apart for one pair of shears to be used, by means of two pairs of shears as follows:

Rig two shears as described above, one on either side of the ditch, except that the back guy is necessary for each.

The shears, when raised, should be nearly vertical, only inclined slightly toward each other, for the strain is sometimes excessive on the guys.

Before raising the shears, connect the heads by a gun tackle purchase, the fall which is slacked off as the shears rise, leading to either side as desired.

The back guys, and the two main tackles for the gun or weights mentioned, should be luff-tackle purchases.

Straps or suitably sized ropes should be used and adjusted over the heads of the shears, as described before for the back guys and for the gun tackle purchase for connecting the shear heads. After the shears are raised and guys well secured, both main tackles are hooked into straps, passed around the gun and trunnions, and the hooks moused.

The gun is passed across by hauling on one tackle and at the same time slacking off the other.

Both falls can be led to the same side of the ditch, if desired, but to different capstans.

When the garrison or casemate gin is used as shears the prypole is replaced by a parting block of the same diameter.

The guys are attached as follows: Middle the rope for the back guys; push the bight through the clevis from below and slip it around both legs; haul the ends back tight and lay them over the

head of the gin to the rear, each part lying between the nearest leg and the parting block, taking care to place canvas under the ropes to prevent chaffing.

The fore guy is hitched around the clevis belt.

A single back guy may be used, formed of a tackle of the same size as the gin tackle, hooked into a strap applied as described for the guy ropes. In this case particular care must be taken to bring the axis of the shears in the vertical plane containing the holdfast and the center of gravity of the weight to be lifted.

A *Gin Pole* is a single spar raised and operated in the same manner as shears. It is generally fitted with four guys, the fore guys extending at an angle of 45° from the line of the front, the rear guys at an angle of 45° from the line of the rear. A cleat is spiked to each side of the spar near the head to keep the guy straps and main tackle sling from slipping down. A turn or two is taken around the spar with the guy straps doubled, letting the ends come clear to allow a guy tackle block to be hooked into each. The main tackle sling is put on in the same way, the upper block being hooked into both ends. A heel cleat is spiked to each side of the spar and the heel lashings, heel posts, and shoes are used as for the shears.

Approximate Size and Length of Spars Required for Shears.

Weight to be raised	Mean Diameter	Length
2 tons	7 to 9 inches	20—30 feet
3 to 5 tons	11 to 13 inches	30—40 feet
5 to 12 tons	13 to 16 inches	40—50 feet
12 to 25 tons	16 to 24 inches	50—60 feet

For a gin pole a spar approximately 1/3 great mean diameter than given above should be used.

HOLDFASTS

To prepare a fastening in the ground for the attachment of guys or purchases, stout pickets are driven into the ground, one behind the other in line of pull. The head of each picket except the last is secured by a lashing to the foot of the picket next behind. The lashings are tightened by rack sticks, the points of which are driven into the ground to hold them in position. The distance between the stakes should be several times the height of the stake above the ground.

Another form requiring more labor but having much greater strength is called a *Deadman,* and consists of a log laid in a transverse trench with an inclined trench intersecting it at its

middle point. The rope is passed down the inclined trench, takes several turns around the log and is fastened to it by half hitches and marline stoppings. If the cable is to lead horizontally or inclined downward it should pass over a log at the outlet of the inclined trench. If the cable is to lead upward this is not necessary, but the anchor log must be buried deeper.